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Patents Act 1990

PROVISIONAL SPECIFICATION

Applicant(s):

UNIVERSITY OF TECHNOLOGY, SYDNEY

Invention Title:

A HYBRID LIGHTING SYSTEM

The invention is described in the following statement:

A HYBRID LIGHTING SYSTEM

Field of the Invention

The present invention broadly relates to a hybrid lighting system.

Background of the Invention

Electrical lighting systems are often very inefficient; usually more than 90% of the electrical energy is not converted into useful light. Sunlight, however, is freely available and attempts have been made to collect sunlight for illumination purposes.

US Patent 6059438 discloses a sunlight collecting and transmitting system. The disclosed system includes three substantially flat collector sheets. The three sheets are stacked on top of each other and are composed of a polymeric material that is doped with dye molecules. The dye molecules absorb sunlight of a particular wavelength and subsequently emit fluorescent light having a slightly larger wavelength. A first sheet is doped with blue emitting dye molecules, a second sheet is doped with green dye molecules and a third sheet is doped with red or orange-red dye molecules. The generated fluorescent light is guided by total internal reflection within the collector sheets and white light can be generated by superimposing the red, green and blue fluorescent light. One of the advantages of this sunlight collecting and transmitting system is that the absorption of the incoming light occurs with reasonable efficiency for all incident directions and the emission of the fluorescent light occurs in arbitrary or random directions. The efficiency of such a system therefore is largely independent of whether the incoming sunlight is diffuse or specular (that

is direct from the sun).

The main contribution to emitted lumens or amount of light is from the green spectral range and hence the green sheet. The human eye is far less sensitive to red and blue light. The main light amount of light therefore is provided by light collectors doped with dye molecules that emit green light whereas light collectors doped with dye molecules that emit red or blue light typically provide less lumens. However, in order to generate white light, a moderate lumen output of red and blue light needs to be added to the emitted green lumens.

Summary of the invention

The present invention provides a hybrid lighting system including:

- at least one light collector for generating an output of fluorescent light, the light collector having an optically transmissive material being doped with dispersed dye molecules arranged to absorb incoming solar light and to emit fluorescence light and
- at least one electrically powered light emitting device that, in use, supplements the output of the light collector to providing light of a predetermined characteristic.

Preferred Features of the Invention

In one preferred embodiment of the invention the or each electrically powered light emitting device, in use, supplements the output of the light collector by providing light of a colour of which the output is deficient. The or each electrically powered light emitting device preferably is arranged to supplement the emitted fluorescence radiation by providing light of a particular colour such

that the addition of the light from the electrically powered light emitting device to the emitted fluorescent light results in light having a predetermined colour.

The predetermined colour preferably is white. The hybrid lighting system preferably includes a light collector that is doped with dye molecules that absorb light in the green spectral range and most preferably also includes a light collector that is doped with dye molecules that emit red or orange-red fluorescent light. In this case the or each electrically powered light emitting device preferably is arranged for the emission of light in the blue spectral range. White light may be generated by adding the blue light emitted form the or each electrically powered light emitting device to the red and to the green fluorescence light emitted from the light collectors. This embodiment has the advantage that no light collector is required for the emission of blue light. Dye molecules that emit blue light usually need to be pumped with UV light and the sunlight includes only a relatively small component of UV light. Further, there are often stability problems with blue dye molecules. It may therefore be difficult to generate even the relatively small intensities of blue light. This arrangement has the further advantage that only two light collectors are required which reduces cost as it simplifies the hybrid lighting system, especially as then associated light guides may be less expensive, smaller in cross section and more flexible.

Blue fluorescent dyes that have good quantum conversion efficiencies are relatively rare. Violet fluorescent dyes are available with good quantum efficiencies, however, output in lumens is much less than that of blue dyes. Thus supplementing fluorescent light

with blue light from a light emitted from a electrically powered light emitting device, such as a light emitting diode (LED), can enhance lumens produced substantially and make generation of neutral white light easier. Colour rendering may also be improved if emitted fluorescent light is sublimated by blue light from an electrically powered light emitting device. Colour and intensity shifts in output light over time may also occur if one of the dyes changes its output relative to the others due to slow degradation. This is most likely the case for violet emitting dye.

In a variation of this embodiment the hybrid lighting system may also include an electrically powered light emitting device that emits red light. In this case only a green light collector sheet is required and provides the main light intensity while relatively small intensities from the blue electrically powered light emitting device and the red electrically powered light emitting device supplement the emitted green fluorescent radiation to generate an output of white light.

Incoming solar light may indirectly be used for illumination purposes by converting the solar light to electric energy using a device such as a solar cell and using the generated electricity to supply a light source such as a LED. However, the same output may be generated more cost efficiently using a stack of light collectors. For example, 1000 lumens are easily generated with the stack of light collectors. To supplement one or two fluorescent colours, eg to supplement green fluorescence light with say 30 to 50 lumens of red and blue LED light source to generate white light, would only require relatively little electrical energy and therefore would be inexpensive. On the other side, the generation of 1000

lumens using solar cells and electrically powered light emitting devices would require a power of approximately 30W and the required solar cells and electrically powered light emitting devices would be relatively expensive.

In another embodiment of the present invention the or each electrically powered light emitting device is arranged to supplement for an intensity deficiency of the output. The or each electrically powered light emitting device preferably is arranged to provide light within the same colour range as that of the emitted fluorescence radiation.

The hybrid lighting system may include electrically powered light emitting devices that are arranged for the emission of red, green and blue light. The hybrid lighting system may also include light collectors arranged for the emission of red, green and blue fluorescent radiation. In this case the light collectors may be used to provide illumination at daytime while at night time the red, green and blue electrically powered light emitting devices are used to provide illumination. Alternatively, at daytime green fluorescence light may be provided by the light collector supplemented by light emitted from the red electrically powered light emitting device and the blue electrically powered light emitting device.

The hybrid lighting system preferably comprises at least one light guide arranged to guide light from the or a respective light collector. The or each electrically powered light emitting device preferably is coupled to the light guide or to a respective light guide. The or each electrically powered light emitting device may be coupled to the or a respective light guide by means of a prism, an optical fibre or a lens. The or each electrically powered light emitting device may also be implanted into the or a

respective light guide. Optional, the or each electrically powered light emitting device may be attached to a respective light transmissive sheet that is in contact with the or each respective light guide.

Alternately the or each electrically powered light emitting device may be mounted in a luminaire which is used to emit light to which the or each light guide may be coupled. Coupling preferably is effected such that electrically powered light emitting device light and fluorescent light is mixed.

The or each electrically powered light emitting device may be powered by a battery or another energy storage device. The or each electrically powered light emitting device may also be powered by a solar cell. Alternatively, the battery or the other storage device may be charged by the solar cell and the hybrid lighting system may then be arranged to provide stand-alone 24 hour lighting or lighting on demand at any time.

The output of the or each electrically powered light emitting device in combination with the output from the or each light collector preferably is controllable to generate light of different colour shades.

The light output from the or each electrically powered light emitting device and the output from the or each light collector sheet may be controllable to generate a substantially constant illumination during clear day conditions, cloudy or night time conditions

A property of the output preferably can be electronically controlled. The output preferably is controllable such that, largely independent on weather conditions and daytime, illumination of predetermined lumens is generated. The output most preferably is controllable such that illumination of predetermined

lumens is generated in a manner to reduce energy consumption.

The electrically powered light emitting device preferably is a light emitting diode (LED).

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings.

Brief Description of the Drawings

Figures 1 to 4 shows perspective schematic representations of a hybrid lighting system according an embodiment of the present invention and

Figure 5 shows the hybrid lighting system according to another embodiment of the present invention.

Detailed Description of preferred embodiments

Initially referring to Figure 1, the hybrid lighting system is now described. The light collector system comprises a light collector sheet and a light guide. Figure 1 shows a light collector sheet 12 and a light guide 13. Light collector sheet 12 and light guide 13 are joined face-to-face. The light collector sheet 12 and the light guide 13 are composed of a transparent plastics material and the light collector sheet 12 is doped with dye molecules that absorb incoming daylight and emit fluorescent radiation. In this example the light collector sheet 12 is doped with dye molecules that absorb and subsequently emit green light. One light emitting diode (LED) 14 that emits blue light and one LED that emits red light 16 are coupled to the light guide 13. Coupling is effected by means of prism 18 and 20. The LEDs 14 and 16 are is powered by a power source (not shown) and, in use, the power is controlled such that, together

with the green fluorescent light emitted by the dye molecules, white light is generated.

It will be appreciated that the LEDs 14 and 16 may be coupled to the light guide using other means for coupling. As an example Figure 2 (a) shows a hybrid lighting system 20 An LED 24 is coupled to the light guide 22 by means of an optical fibre 26.The light guide 22 is connected to a light collector sheet 23. It will also be appreciated that the light guide may not be provided in form of a flat sheet. Figure 2 (a) shows a variation of this embodiment 27 where a light guide is provided in form of an optical cable 28. The LED 24 is coupled to the optical cable 28 by means of the optical fibre 26. The light guide 26 is connected to a light collector 25 by means of a coupler 29.

Figure 3 shows another alternative in which a hybrid lighting system 30 comprises a light guide 32 that is coupled to a light collector sheet 33. An LED 34 is coupled to the light collector.

Figure 4 shows a hybrid lighting system 40 comprising a light guide coupled to a light collector sheet 43. An LED 44 is implanted into the light guide 42. In this case the LED 44 is powered by a battery 46 that accumulates charges provided by a solar cell 48.

The light collector system may comprise a plurality of light collector sheets and LEDs. A part of such a system is shown in Figure 5. In this embodiment, the hybrid lighting system 50 comprises light guides 52, 54 and 56 which are connected to respective light collector sheets (not shown) which are arranged for the emission of red, green and blue fluorescent light, respectively. LEDs 58, 60 and 62 are implanted into the light guides 52, 54 and 56 and are also arranged for the emission of red,

green and blue light. In this case the light collector sheets 52, 54 and 56 may be used to provide illumination during daytime and the LEDs may be used to provide illumination during night time. Alternatively, one or more of the light collector sheets may be used together with one or more of the LEDs.

It will be appreciated that alternately the or each LED may be placed alongside or within a luminare that is attached to an end of the or each light guide and through which light is emitted for illumination purposes. In any case, The LED's are positioned such that fluorescent light and LED light mixes.

Although the invention has been described with reference to particular examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms. For example, the system may comprise electrically powered light emitting devices other than LEDs.

It is to be understood that the reference that is made to US Patent 6059438 does not constitute an admission that the documents form a part of the common general knowledge in the art, in Australia or any other country.

The Claims defining the invention are as follows:

1. A hybrid lighting system including:

- at least one light collector for generating an output of fluorescent light, the light collector having an optically transmissive material being doped with dispersed dye molecules arranged to absorb incoming solar radiation and to emit fluorescence light and
- at least one electrically powered light emitting device that, in use, supplements the output of the light collector such that an output of light of a predetermined characteristic is generated.

2. The hybrid lighting system as claimed in claim 1 wherein the or each electrically powered light emitting device, in use, supplements the output of the light collector by providing light of a colour of which the output is deficient.

3. The hybrid lighting system as claimed in claim 2 wherein the or each electrically powered light emitting device, in use, supplements the output of the light collector such that an output of white light is generated.

4. The hybrid lighting system as claimed in claim 2 wherein the or each electrically powered light emitting device, in use, supplements the output to obtain an output of a predetermined colour rendering.

5. The hybrid lighting system as claimed in any one of the preceding claims wherein the or each light collector is doped with dye molecules that emit light in the green spectral range.

6. The hybrid lighting system as claimed in claim 5 including an electrically powered light emitting device arranged to emit blue light and an electrically powered light emitting device arranged to emit red or orange-red light.

7. The hybrid lighting system as claimed in any one of the claims 1 to 4 including a light collector that is doped with dye molecules that emit green light and including a light collector that is doped with dye molecules that emit red or orange-red fluorescent light and wherein the or each electrically powered light emitting device is arranged to emit light in the blue spectral range.

8. The hybrid lighting system as claimed in claim 1 wherein the or each electrically powered light emitting device is arranged to supplement for an intensity deficiency of the output.

9. The hybrid lighting system as claimed in claim 8 wherein the or each electrically powered light emitting device is arranged to provide light within the same colour range as that of the emitted fluorescence radiation.

10. The hybrid lighting system as claimed in claim 9 including electrically powered light emitting devices that, in use, emit red, green and blue light and light collectors that emit red, green and blue fluorescent light.

11. The hybrid lighting system as claimed in any one of the preceding claims wherein the or each electrically powered light emitting device is coupled to the or a respective light guide.

12. The hybrid lighting system as claimed in claim 11 wherein the or each electrically powered light emitting device is coupled to the or a respective light guide by means of a prism.

15. The hybrid lighting system as claimed in claim 11 wherein the or each electrically powered light emitting device is coupled to the or a respective light guide by means of an optical fibre.

16. The hybrid lighting system as claimed in claim 11 wherein the or each electrically powered light emitting device is implanted into the or a respective light guide.

17. The hybrid lighting system as claimed in any one of the preceding claims wherein the or each electrically powered light emitting device is, in use, powered by a battery.

18. The hybrid lighting system as claimed in claim 17 wherein the or each battery is, in use, charged by a solar cell.

19. The hybrid lighting system as claimed in claim 1-17 wherein the or each electrically powered light emitting device is, in use, powered by a solar cell.

20. The hybrid lighting system as claimed in any one of claims 1 to 10 wherein the or each electrically powered light emitting device is positioned in a luminare which, in use, emits the output for illumination purposes.

21. The hybrid lighting system as claimed in any one of the preceding claims wherein the colour of the output can be altered.

22. The hybrid lighting system as claimed in any one of the preceding claims wherein a property of the output can be electronically controlled.

23. The hybrid lighting system as claimed in claim 22 wherein the output is controllable such that, largely independent on wether conditions and daytime, illumination of predetermined lumens is generated.

24. The hybrid lighting system as claimed in claim 23 wherein the output is controllable such that illumination of predetermined lumens is generated in a manner to reduce energy consumption.

25. The hybrid lighting system as claimed in any one of the preceding claims wherein the electrically powered light emitting device is a light emitting diode (LED).

Dated this 14th day of NOVEMBER 2002
UNIVERSITY OF TECHNOLOGY, SYDNEY
By their Patent Attorneys
GRIFFITH HACK

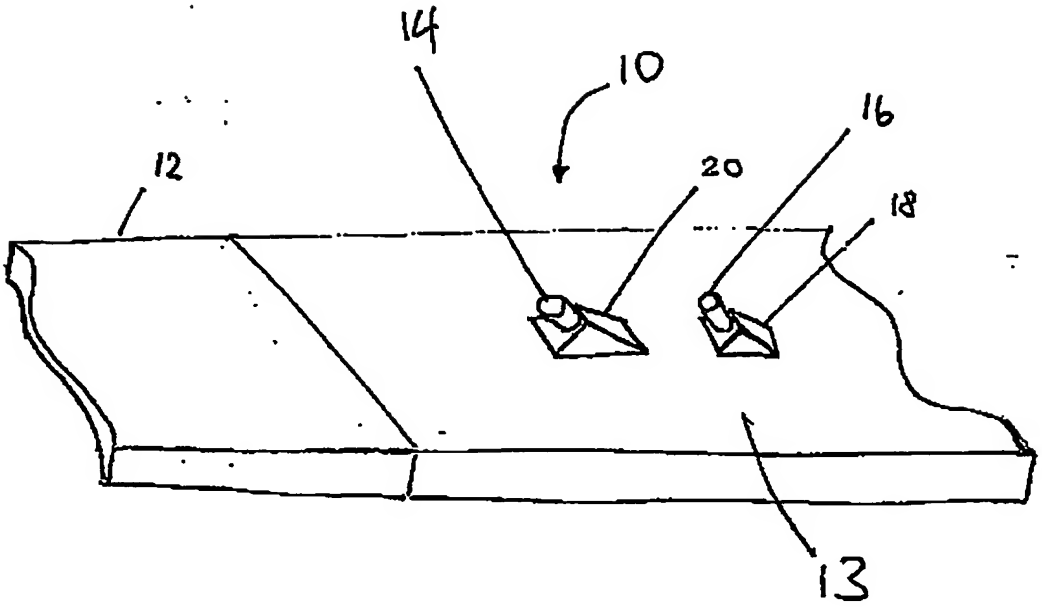

FIG. 1

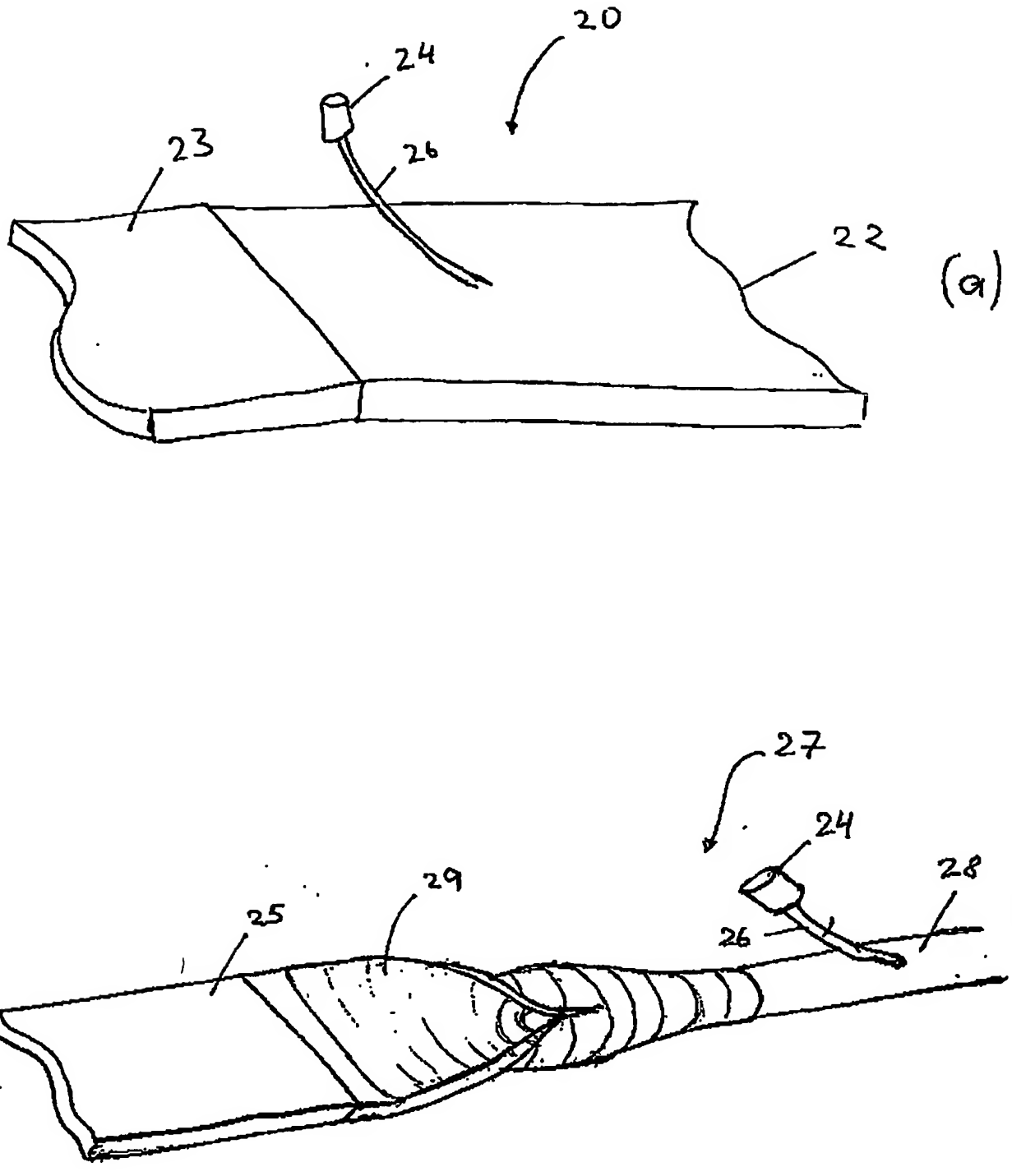

FIG. 2

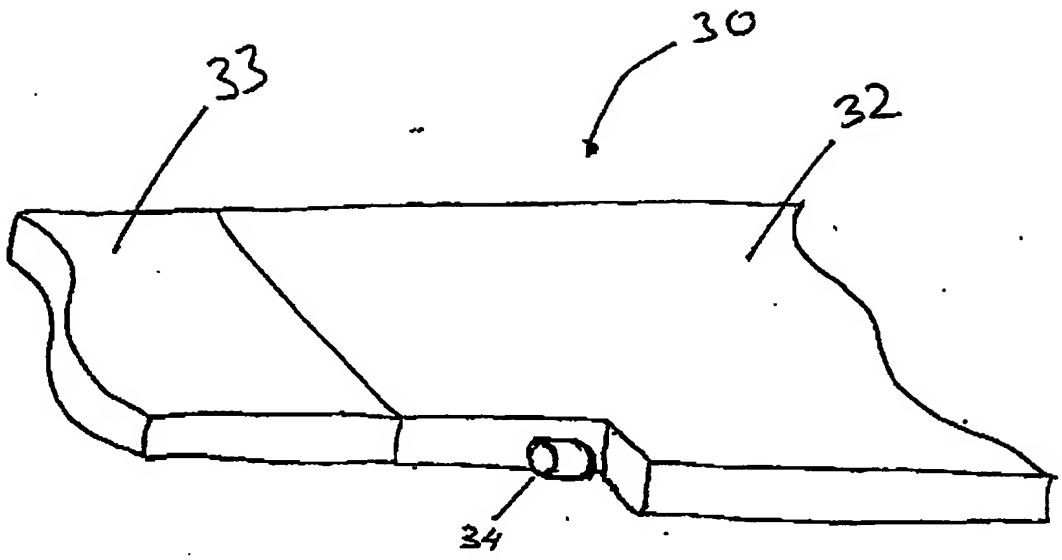

FIG. 3

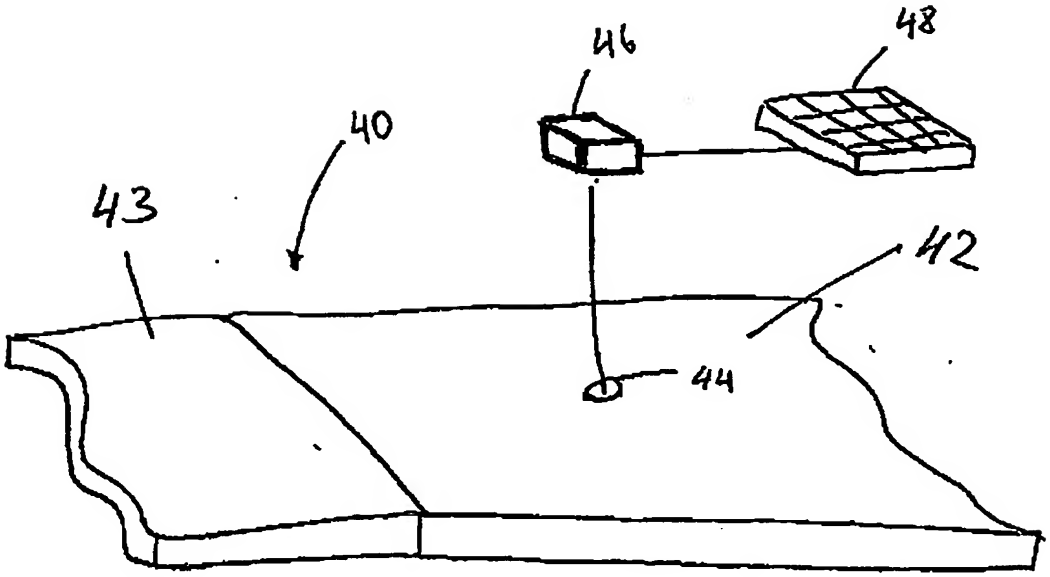

FIG. 4

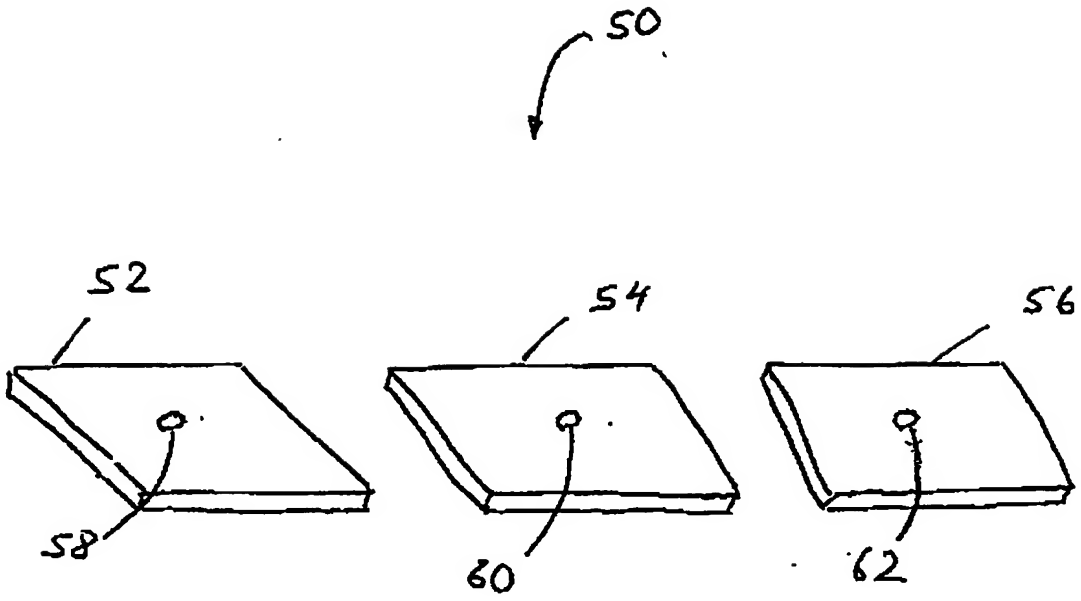

FIG. 5